S
333.79
E29gra
1986
C.1

PLEASE RETURN

MONTANA STATE LIBRARY
1515 E. 6th AVE.
HELENA, MONTANA 59620

ADDENDUM
TO THE
GUIDE TO THE RENEWABLE ENERGY REPORT LIBRARY

February 1986

Prepared by

Montana Department of Natural Resources
and Conservation
Energy Division
1520 East Sixth Avenue
Helena, Montana 59620

MONTANA STATE LIBRARY
S 333.79 E29gra 1986 c.1
Addendum to the Guide to the renewable e
3 0864 00056626 8

S
333.79
E29gra
1986
c.1

PLEASE RETURN

MONTANA STATE LIBRARY
1515 E. 6th AVE.
HELENA, MONTANA 59620

ADDENDUM
TO THE
GUIDE TO THE RENEWABLE ENERGY REPORT LIBRARY

February 1986

Prepared by

Montana Department of Natural Resources
and Conservation
Energy Division
1520 East Sixth Avenue
Helena, Montana 59620

TABLE OF CONTENTS

Page

SOLAR

Active Systems 1

Monitoring, Research, and Modeling 3

WIND 5

BIOMASS

Liquid and Alcohol Fuels 7

Solid Fuels 11

Biogas 19

HYDROPOWER 20

ENERGY CONSUMPTION ANALYSES 23

NOTICE

The following reports were prepared through projects sponsored by the Montana Department of Natural Resources and Conservation. The reviews and opinions of authors expressed in the reports are not necessarily those of the Department nor any Department employee.

mt. 86-263 C

SOLAR
Active Systems

TITLE:	**VERTICAL WALL SOLAR AIR HEATERS: A DESIGN AND CONSTRUCTION MANUAL**
I.D. NUMBER:	82-1019
REPORT AUTHOR:	Lewis Dahl, Sheila Dahl, David Olen
DATE WRITTEN:	August 1982
PROJECT LOCALE:	Town of Conrad; central Montana
TOPICS:	How to design and build vertical solar collectors
SUGGESTED AUDIENCE:	General public, solar designers, and contractors
REPORT SUMMARY:	This is a construction manual containing specifications on materials and equipment for building vertical solar collectors. The major components of flat-plate solar collectors are explained, as are the advantages and disadvantages of the materials that can be used to build them. The report is written in clear, concise, nontechnical language.

TITLE: TWO INNOVATIVE SOLAR RETROFITS FOR THE MISSOULA SENIOR CITIZENS CENTER

I.D. NUMBER: 82-1010

REPORT AUTHOR: Palmer Johnson

DATE WRITTEN: September 1984

PROJECT LOCALE: Missoula, Montana

TOPICS: Solar retrofit, Trombe wall, lockout thermostats, and solar water heating

SUGGESTED AUDIENCE: Commercial building owners, institutional building managers, solar designers

REPORT SUMMARY: The Missoula Senior Citizens Center received an energy retrofit that included: (1) insulating the 8,000 square foot attic to R-38, adding clear mylar, roll-down shades to act as storm windows, (2) installing a lockout thermostat to turn the boiler off when outside temperatures are between 55° and 65°F, (3) installing a Trombe wall on 1,500 square feet of the building's south wall, and (4) installing hydronic, evacuated tube collectors to provide domestic hot water and space heat. The report describes the performance of only two retrofits--the solar water heating system and the Trombe wall. The solar water heating system experienced several initial problems that were finally resolved. However, oversizing of the water heating system has caused persistent problems. The system was designed to produce enough hot water to meet the demands of a food service operation that is no longer located in the building. The Trombe wall not only helps to insulate the thick masonry south wall but also absorbs incoming solar radiation. It is fitted with a fiberglass sunscreen curtain for summer shading.

SOLAR
Monitoring, Research, and Modeling

TITLE: SOLAR WATER HEATER TEST PROJECT

I.D. NUMBER: 83-1029

REPORT AUTHOR: Charless Fowlkes

DATE WRITTEN: November 1984

PROJECT LOCALE: Bozeman, Montana

TOPICS: Solar water heating systems

SUGGESTED AUDIENCE: Solar designers and contractors

REPORT SUMMARY: Three solar water-heating systems were tested to determine how much heat they could collect. The three systems tested were an active solar water-heating system, an integral passive solar system, and a homemade batch heater. The active system provided the most effective performance. The performance of that system was nearly matched by an integral passive solar system. A homemade batch heater was found useful only for preheating water in the summer. The report includes monthly summaries of the performance of each of the three systems. These summaries include outdoor temperature, solar insolation, pipe heat losses, and system gain from solar energy.

TITLE: DEMONSTRATION AND PERFORMANCE OF A SOLAR DRY KILN IN WESTERN MONTANA

I.D. NUMBER: 132-811

REPORT AUTHOR: Edwin J. Burke

DATE WRITTEN: December 1982

PROJECT LOCALE: Lubrecht Experimental Forest, near Missoula, Montana

TOPICS: Construction specifications for a solar lumber dry kiln

SUGGESTED AUDIENCE: Lumber manufacturers, wood products workers, and solar technicians

REPORT SUMMARY: The report concludes that a solar dry kiln is an easy to build structure that can decrease drying costs for small sawmills, and allow them to enter the market with a higher-quality product. The demonstration kiln described in this report has a 6,500 board foot capacity, and cost $54,931 to build. The report includes a description of construction details and suggestions for improving other solar kilns.

WIND

TITLE: MONTANA WIND ENERGY ATLAS

I.D. NUMBER: GR-594

REPORT AUTHOR: GeoResearch, Inc.

DATE WRITTEN: November 1983

PROJECT LOCALE: Statewide

TOPICS: Wind energy

SUGGESTED AUDIENCE: Researchers, resource developers, energy planners, engineers

REPORT SUMMARY: This is a comprehensive report of wind energy data in Montana. Wind data were collected at 149 wind monitoring sites throughout Montana. Data from 50 locations are summarized. The detailed description of the 50 sites includes a discussion of collection methods and data quality as well as information on other factors meaningful to the potential development of the resource. Additional data is included for two sites--one near Great Falls and the other by Livingston--where wind speed data were gathered at several heights. The report examines wind energy measurement programs conducted in Montana, including site location, monitoring agencies, length of data collection, and evaluation of the information. The study also describes the four wind provinces found in Montana, and contains maps indicating the average annual wind speed and wind power density for different parts of the state.

TITLE: WIND DATA GATHERED AT NINE MONITORING SITES IN MONTANA

I.D. NUMBER: 82-1016

REPORT AUTHOR: Gunderson Consulting Service

DATE WRITTEN: July 1984

PROJECT LOCALE: Montana towns of Cascade, Chinook, Choteau, Circle, Conrad, Helena, Lambert, Power, and Rudyard

TOPICS: Monthly average wind speed, average wind pressure, average wind power density

SUGGESTED AUDIENCE: Meteorologists, pilots, wind generator owners

REPORT SUMMARY: Gunderson Consulting Service took wind measurements at nine sites in Montana to determine if the wind was powerful enough to effectively generate electricity. The measurements were made with an A-11-132 dual strip chart recorder, a 4-pole cup anemometer, and an A75-301 wind direction sensor powered by a 12-volt battery. The strip chart records a wind speed reading every 2 seconds. Data given for each of the nine locations are: monthly average wind speed, average wind pressure, the average temperature, and the average wind power density. Generally, if the average wind speed is below 12 miles per hour for six months of the year, the report concluded a wind generator would not be efficient.

BIOMASS
Liquid and Alcohol Fuels

TITLE: FUEL GRADE ETHANOL PRODUCTION USING WOOD WASTE (RESIDUES) AT SELECTED SITES IN MONTANA

I.D. NUMBER: 451-811

REPORT AUTHOR: MultiTech

DATE WRITTEN: June 1985

PROJECT LOCALE: Anaconda, Lincoln, and Livingston, Montana

TOPICS: Ethanol production, supply of waste wood, economic feasibility of ethanol production, plant design and construction, environmental and regulatory requirements

SUGGESTED AUDIENCE: Forest products manufacturers, ethanol producers

REPORT SUMMARY: This report discusses the feasibility of building an ethanol plant at three different locations that would use wood waste to produce fuel grade ethanol and byproducts of methanol, furfural, and molasses. Anaconda, Lincoln, and Livingston were selected as sites for the study. Each of the plants would use a modified Madison wood process, and that process is illustrated in referenced drawings. Construction and operation of the plants is technically feasible, However, the Anaconda plant, operating at a capacity of 2.5 million gallons per year would lose about $300,000 annually. Further, there is not enough waste wood within a twenty-five mile radius of Anaconda to supply such a plant. Therefore, the possibility of building smaller plants was analyzed. Plants with smaller capacity--0.2 and 1.25 million gallons per year--could be operated profitably with wood costs of $20 per ton at all locations. The plant costs are detailed, and estimates are provided for the cost of both new and used equipment for all three plant sizes. Wood resource assessments are given for Anaconda, Lincoln, and Livingston.

TITLE: LIQUID FUEL AND CHEMICALS FROM RENEWABLE CELLULOSIC BIOMASS

I.D. NUMBER: 83-1031

REPORT AUTHOR: Daniel Shaffer, Montana State University

DATE WRITTEN: March 1985

PROJECT LOCALE: Montana State University

TOPICS: Ethanol production, delignification, hemicellulose, enzymatic processes for extracting glucose from lignocellulosic materials, gasohol

SUGGESTED AUDIENCE: Ethanol producers, chemical engineers

REPORT SUMMARY: The report addresses the problem of finding a simple, inexpensive way to prepare lignocellulosic material. The report includes analyses by TAPPI standards for Montana-specific wheat and barley straw, lodgepole pine, and Douglas fir for fermentation to produce ethanol. The report describes the optimum conditions for the autohydrolysis of wheat straw, and subsequent delignification using alcohol. High yields of xylose sugars from hemicellulose were achieved for all materials, but lignin removal was only moderate for wheat and barley straw, and essentially zero for woody biomass. The other substances were tried at these optimal conditions and produced marginal results for barley straw, but were not effective for woody biomass.

TITLE: CONSTRUCTION AND OPERATION OF A PORTABLE STILL TO PROCESS AGRICULTURAL CULLS FOR FUEL GRADE ETHANOL

I.D. NUMBER: 439-811

REPORT AUTHOR: Lawrence L. Stookey, P.E. for Agrifuels of America

DATE WRITTEN: June 1984

PROJECT LOCALE: Flathead Valley, Montana

TOPICS: Portable still

SUGGESTED AUDIENCE: Ethanol producers and plant designers

REPORT SUMMARY: The report contains recommendations to improve a portable still that produces over 16 gallons of fuel grade ethanol per hour from beer fermented from potatoes. Recommendations are given for improving the distillation and the fermentation process. Suggestions range from changing liquefaction enzymes to cleaning pipes and tanks with chlorine. The report has appendixes on operating instructions for the still and on the economics of operating the still.

TITLE: BIOMASS POTENTIAL OF LEAFY SPURGE

I.D. NUMBER: 445-811A

REPORT AUTHOR: Stanley M. Wiatr, Eastern Montana College

DATE WRITTEN: June 1984

PROJECT LOCALE: South central Montana

TOPICS: Studying a beneficial use for leafy spurge, the production of biocrude oil or ethanol from leafy spurge

SUGGESTED AUDIENCE: Chemical engineers, biomass researchers, agronomists, biochemists

REPORT SUMMARY: Natural stands of leafy spurge were harvested, processed, and chemically tested, and it was found that the plant's oil yield varies by harvest time and plant location. The oil content of leafy spurge is far less than that of rubber, which is a good oil-producing plant. The whole plant could be converted to biocrude oil, or the plant could be used as a source of lignin, crude fiber, and byproducts of extractable oils, polyphenols, protein, and fermentable carbohydrates. The report suggests that cultivated stands of leafy spurge would yield more oil or more plant biomass than the wild stands. Even if cultivated, it's doubtful that leafy spurge would be a good source of either plant biomass or biocrude oil. The report includes tables of data from the numerous tests on the plant samples.

TITLE: FUEL BEETS--A PROSPECTIVE ENERGY CROP FOR MONTANA

I.D. NUMBER: 82-1005

REPORT AUTHOR: Stanley Wiatr, Eastern Montana College

DATE WRITTEN: March 1984

PROJECT LOCALE: South central Montana

TOPICS: Fodder beet cultivars, and their suitability for use in producing ethanol

SUGGESTED AUDIENCE: Beetgrowers, chemical engineers, ethanol producers, agronomists

REPORT SUMMARY: Fodder beets yield three to eight times more fermentable carbohydrates than barley, wheat, and corn. Beets have the potential to produce between 558 and 1,022 gallons of alcohol per acre. The shoot and root biomass were separated into six components: oils, polyphenols, ethanol extractives, crude fiber, lignin, and residual biomass. The report concludes that if fuel beets were grown on 10 percent of the land presently in beet production, the resulting fuel alcohol industry could produce over 100 million gallons of alcohol annually. Fuel beets, such as the cultivars Meka Otofte and Krake, could produce 10 to 30 percent more alcohol per acre than high-quality sugar beets. The report includes tables with information on the yield of sugar, alcohol, and biomass from a number of beet cultivars.

BIOMASS
Solid Fuels

TITLE: COGENERATION FEASIBILITY STUDY COMPARISON OF RANKINE VS STIRLING ENGINES ADAPTED TO A SOLID-FUEL COMBUSTOR

I.D. NUMBER: RJB-661

REPORT AUTHOR: Robert J. Boucher

DATE WRITTEN: November 1983

PROJECT LOCALE: Bonner, Potomac area, Montana

TOPICS: Adaptation of an engine to a solid-fuel combustor

SUGGESTED AUDIENCE: Mechanical engineers, solid fuel engine designers, solid fuels researchers, researchers on engine design

REPORT SUMMARY: The report investigates the possibility of adding an external combustion engine to a high-efficiency wood combustor designed and built by the author. The report examines five external combustion engines. The report finds that adapting a Rankine cycle engine would be possible, and identifies the preliminary design, economics, and development costs. Several reports by engineering firms are appended: Power Generation from Waste Heat Using Organic Rankine Cycle Systems; Ormat Energy Converters for Electrical Power Generation from Unused Industrial Process Heat or Geothermal Energy; Design of a Low Pressure Air Engine for Third World Use; The Development of a 1 kW Electrical Output Free Piston Stirling Engine Alternator Unit; Research on the Sodium Heat Engine; The Scroll Machine.

TITLE: THE FEASIBILITY OF USING BIOMASS FOR FUEL AT THE UNIVERSITY OF MONTANA

I.D. NUMBER: BS-733

REPORT AUTHOR: B.B. Stout, J.A. Parker, and Steve Ottenbreit

DATE WRITTEN: October 1985

PROJECT LOCALE: Missoula, Montana

TOPICS: Boiler retrofits, hog fuel, biomass utilization, wood resources

SUGGESTED AUDIENCE: Institutions, industry

REPORT SUMMARY: The University of Montana investigated the possibility of using hogged wood to provide heat and possibly electricity for the campus. The report identifies the legal, environmental, and technical feasibility of a heating and cogenerating design. Two options investigated include: (1) The University could convert one of its three Keeler boilers to burn wood instead of natural gas. (2) Alternatively, the University could purchase a new high-pressure boiler to produce steam and electricity. The recommended second alternative would save the university about $300,000 per year, in terms of 1984 dollars, after an investment of $4,412,000 for the 1.2 MW cogeneration plant. Waste wood resources from the Lubrecht forest were also identified. About a quarter of the wood would be supplied from the Lubrecht Experimental Forest.

TITLE: RESIDENTIAL WOOD FUEL USE ASSESSMENT

I.D. NUMBER: ECO-739

REPORT AUTHOR: ECO Northwest, Ltd.

DATE WRITTEN: September 1984

PROJECT LOCALE: Statewide

TOPICS: Wood use analysis, forecasting wood energy use, computer modeling of wood consumption

SUGGESTED AUDIENCE: U.S. Forest Service officials, firewood and woodstove suppliers

REPORT SUMMARY: The report analyzes the use of wood for heating homes in Montana. It discusses past patterns and projects future use. The methods used to estimate past and future levels of residential wood consumption are fully explained. They include survey analysis, econometric, and computer models. Computer printouts project wood consumption based on a number of different assumptions. The variables that influence wood consumption are discussed. Findings of a statewide general public survey designed to determine attitudes toward wood heating, wood costs, pollution, and inconvenience are included. The report gives a range of residential wood use forecasts through 1995 and a discussion of the probability of each.

TITLE: OVERALL EFFICIENCY OF AN INTEGRATED ENERGY PRODUCTION MANAGEMENT SYSTEM AND A FIREPLACE INSERT

I.D. NUMBER: 84-1036

REPORT AUTHOR: Richard G. Wrench

DATE WRITTEN: October 1984

PROJECT LOCALE: Kalispell, Montana, but applicable statewide

TOPICS: Managing a home for energy efficiency and using a fireplace insert

SUGGESTED AUDIENCE: Heating, ventilating, and air conditioning contractors, home builders and owners

REPORT SUMMARY: The report describes Mr. Wrench's experience with a wood furnace that was used to heat domestic water for his house in Kalispell, Montana. Other energy conservation features in Mr. Wrench's home included a set-back thermostat, an air-to-air heat exchanger, and a fireplace insert. The energy efficiency of the home was measured using both the Mitlas method and fixed heat loss calculations. Mr. Wrench reports the system efficiency is 73.5 percent using the Mitlas method and 87 percent using fixed calculations.

TITLE: UTILIZATION OF BIOMASS TO DRY WHOLE CORN

I.D. NUMBER: 83-1025

REPORT AUTHOR: Mark A. Little, Dr. Lee Erickson, Dr. Gilbert F. Stallknecht

DATE WRITTEN: October 1984

PROJECT LOCALE: Montana State University, Southern Agricultural Research Station near Huntley, Montana

TOPICS: Biomass-fired corn dryer

SUGGESTED AUDIENCE: Feed corn growers, biomass energy systems designers

REPORT SUMMARY: The report summarizes the design, construction, and demonstration of a biomass-fired corn dryer at Huntley, Montana. The report describes the drying system, which consists of a direct combustion incinerator burner, a feeding unit, and drying and storage bins. The report analyzes the efficiency of a commercial biomass burner which can use unprocessed straw, corn cobs, corn stalks and husks as fuels. Also included are design and operation recommendations based on the system's operation and on computer simulations.

TITLE: STICK WOOD BOILER DEMONSTRATION PROJECT FOR RESIDENTIAL APPLICATIONS

I.D. NUMBER: 320-811

REPORT AUTHOR: Carol and Mike Gauthier

DATE WRITTEN: September 1984

PROJECT LOCALE: Grant Creek, near Missoula, Montana

TOPICS: Woodburning "boiler" hot water heater for space and domestic hot water heating

SUGGESTED AUDIENCE: Home owners, general public, heating contractors

REPORT SUMMARY: A Dumont "Tempest" boiler was installed in a home on Grant Creek near Missoula. The "boiler" used eight cords of wood in a year to heat the home and the domestic water. Tables are provided that compare the efficiency of heating with the boiler to the efficiency of heating with electricity, natural gas, propane, and fuel oil. The report finds that, given 1984 prices, natural gas is the cheapest heating fuel, but that the boiler is a more cost-effective heating system if it is used to replace propane or fuel oil. The report contends that the boiler will usually pay for itself in twenty years. Attachments to the report include: Tempest 130 Plant Efficiency Calculations; A Report from the Energy Testing Laboratory of Maine; Tempest Owner's Manual; Emissions and Efficiency Test; A Field Study of Furnace Efficiency in Homes.

TITLE: LIBBY BIOENERGY PROJECT

I.D. NUMBER: 84-1045

REPORT AUTHOR: Rayson Brothers Logging Co., David G. Vandersett, P.E.

DATE WRITTEN: May 1985

PROJECT LOCALE: Libby, Montana

TOPICS: Gasifiers, Fluidized bed combustion

SUGGESTED AUDIENCE: Industrial consumers of fuel oil, industrial operators of drying processors, sawmill operators

REPORT SUMMARY: The report investigates the feasibility of using wood or coal waste to replace oil as a long-term, cost-effective, dependable energy source for drying. Either waste wood or waste coal could be supplied more cheaply than the fuel oil or propane on which the plant now relies. The report involves Libby area wood and coal resource assessment, preliminary designs and costs for in-woods wood fuel harvesting, preliminary designs and costs for both a wood and coal fluidized bed gasifier system and storage, designs and costs for a cogeneration option, and an economic analysis of the systems to fire a fluidized-bed vermiculite dryer.

TITLE: OPERATION OF A PORTABLE CHIPPER TO CHIP WASTEWOOD AT SAWMILLS IN WESTERN MONTANA FOR USE AS BOILER FUEL AT A NEARBY PULP MILL

I.D. NUMBER: NPCC-621

REPORT AUTHOR: Tom Nuxoll, Dan Poling

DATE WRITTEN: August 1984

PROJECT LOCALE: Western Montana

TOPICS: Biomass for boiler fuel

SUGGESTED AUDIENCE: Sawmill operators, boiler operators

REPORT SUMMARY: The report describes the feasibility of operating a mobile chipping plant to process wood slabs and edgings accumulated at several sawmills in western Montana for use as hog fuel at a Missoula pulp mill. The equipment used, site characteristics, resource availability, and marketing considerations, as well as possible project alternatives are discussed. The study found the project's feasibility is heavily dependent on two factors--the availability of the resource and a market for the hog fuel within an approximate 70 mile area.

TITLE: MUNICIPAL SOLID WASTE-TO-ENERGY PROJECT FOR WESTERN MONTANA COLLEGE AT DILLON

I.D. NUMBER: 468-811

REPORT AUTHOR: Western Montana College, Claud Matney

DATE WRITTEN: July 1984

PROJECT LOCALE: Dillon, Montana

TOPICS: Biomass, solid waste disposal

SUGGESTED AUDIENCE: Physical plant managers, solid waste engineers, alternative fuels researchers

REPORT SUMMARY: The report provides an economic analysis and a design for a garbage-to-energy facility to cogenerate heat and electricity at Western Montana College. The report includes equipment specifications, site analysis, and sizing for a mass-burn incinerator and boiler. The computer model used to determine the preliminary economic feasibility is described, and a calculation is given for determining if a project like this is feasible in other communities. The biomass-fired facility could provide heat for the college, but the electrical cogeneration is not economical in 1984 because of the low buy-back rate.

TITLE: BIOMASS CONVERSION USING GASIFICATION AND CATALYTIC COMBUSTION: PROCESS DESIGN AND APPLICATION

I.D. NUMBER: LJW-650

REPORT AUTHOR: Lawrence Watters

DATE WRITTEN: December 1984

PROJECT LOCALE: Thompson Falls, Montana

TOPICS: Downdraft gasifier

SUGGESTED AUDIENCE: Wood products industry, mechanical engineers, biomass researchers, catalytic combustion researchers

REPORT SUMMARY: The report reviews three preliminary designs for a small variable (1-5 MMBtu/hr) waste wood gasification system and recommends a downdraft gasifier for drying wood products at a small specialty mill near Thompson Falls. The report gives a detailed discussion of the components and preliminary economics of the gasification system, which uses catalytic combustion.

BIOMASS
Biogas

TITLE: MONTANA FARMS: BIOGAS/COGENERATION FEASIBILITY STUDY

I.D. NUMBER: 83-1028

REPORT AUTHOR: Robert Hunter, Brown and Caldwell, Consulting Engineers

DATE WRITTEN: November 1984

PROJECT LOCALE: Townsend, Montana

TOPICS: On-farm biogas production, cogeneration

SUGGESTED AUDIENCE: Commercial egg/poultry producers, other animal confinement managers

REPORT SUMMARY: The report evaluates the feasibility of producing biogas from chicken manure, and using the biogas to generate electricity and heat for an egg farm in Townsend, Montana. Three systems were assessed for technical and economic feasibility. The report contains designs for and the results of laboratory testing of the biogas-producing systems. Conventional anaerobic digestion of chicken manure was found to be the most viable alternative for this operation. The chicken manure was evaluated for energy content in relation to the on-farm energy requirements. The projected costs and benefits are summarized for each system. The economic success of the project is dependent on the cost of financing the construction of the biogas/manure system and the availability of an assured market price for any surplus electricity produced.

HYDROPOWER

TITLE:	STREAMFLOW CHARACTERISTICS OF MOUNTAIN STREAMS IN WESTERN MONTANA
I.D. NUMBER:	84-244
REPORT AUTHOR:	Charles Parrett, J.A. Hull
DATE WRITTEN:	May 1984
PROJECT LOCALE:	Western Montana
TOPICS:	Stream flows
SUGGESTED AUDIENCE:	Hydropower developers, land-use managers, water-rights administrators
REPORT SUMMARY:	The report addresses a study by DNRC and the U.S. Geological Survey that gathered data on mountain streamflow in western Montana and refined previous streamflow estimation techniques. Fifty-one streamflow measurement sites were established, mainly in the Kootenai River and Swan River basins. Measurements were made monthly from March 1982 through February 1983. The study also reports miscellaneous streamflow measurements made during other investigations at 21 sites, mostly in the Bitterroot River drainage. The data was used to estimate long-term flow characteristics at each site. There is a thorough discussion of the regression analyses and other calculations that relate mean annual flow to drainage area and precipitation.

TITLE: SMALL-SCALE HYDROELECTRIC POTENTIAL OF THE MILL DIVERSION CHANNEL IN LEWISTOWN, MONTANA

I.D. NUMBER: 82-1018

REPORT AUTHOR: MultiTech

DATE WRITTEN: May 1985

PROJECT LOCALE: Lewistown, Montana

TOPICS: Small hydroelectric plants

SUGGESTED AUDIENCE: Hydropower developers

REPORT SUMMARY: The city of Lewistown plans to build a small hydropower plant that could generate 1,244,616 kWh of electricity annually from a Kaplan turbine using 237 cubic feet per second of water. The report describes the cost of the power to be sold and the capital costs of construction. It provides an environmental analysis of the project's expected impacts, and the steps Lewistown plans to take to eliminate or ameliorate the negative effects of the project.

TITLE: CEDAR CREEK DAM HYDROELECTRIC PROJECT: FEASIBILITY STUDY

I.D. NUMBER: 82-1012

REPORT AUTHOR: City of Columbia Falls, Eric Schulz

DATE WRITTEN: December 1983

PROJECT LOCALE: Columbia Falls, Montana

TOPICS: Hydropower

SUGGESTED AUDIENCE: Hydropower developers

REPORT SUMMARY: The report investigates the feasibility of adding a hydroelectric power plant to a dam on Cedar Creek near Columbia Falls. It describes the steps involved in determining the potential for hydropower production: site analysis, data collection, marketing analysis, preliminary design, equipment selection, and cost. Based on several plant and turbine designs, hydropower generation was found to be infeasible due mainly to the small amount of energy that could be produced at the site.

TITLE: CASCADE CREEK HYDROPOWER PROJECT

I.D. NUMBER: 654-810

REPORT AUTHOR: Hydrodynamics of Bozeman, Tom and Jody Budde

DATE WRITTEN: September 1983

PROJECT LOCALE: Cascade Creek in Park County, Montana

TOPICS: Design and operation of a small hydroplant and associated transmission facilities

SUGGESTED AUDIENCE: Hydropower developers

REPORT SUMMARY: This report describes a 75 kW hydropower project built on Cascade Creek in Park County, Montana. Electricity from the project is wheeled through the Park Electric Cooperative to Montana Power Company. The concrete diversion structure is four feet high by 20 feet long. The impoundment it forms has a capacity of about 760 cubic feet, and releases up to 90 cubic feet per minute (1.5 cfs) with an effective head of up to 844 feet. The induction generator is run by a pelton impulse turbine. The power plant produces about 361,500 kWh each year. The electricity flows into the grid through a transformer, which is made possible by a switch gear, capacitive power factor correction, metering, and a disconnect switch that can be locked. The plant is working well, although power shortages in the grid have taken it off line from time to time. The return on the investment is expected to be 18 percent, but the plant had not been in operation long enough to determine if this is the case.

ENERGY CONSUMPTION ANALYSES

TITLE: A SIMPLIFIED METHOD FOR DETERMINATION OF BELOW GRADE HEAT LOSS

REPORT AUTHOR: Danny Parker

DATE WRITTEN: November 1984

TOPICS: Calculations for determining insulation thickness, heat loss, F-factors, U-values, and soil conductivity

SUGGESTED AUDIENCE: Heating contractors, insulation contractors, architects, engineers

REPORT SUMMARY: The study presents a method for calculating heat losses from heated and unheated basements, shallow basements, vented and unvented crawl spaces, wood foundations for crawl spaces, and concrete slabs. The study refines heat loss coefficients provided in ASHRAE by correlating below-grade heat loss to average ground temperature--rather than surrounding air temperatures. The report contains a table of F-factors for each kind of basement based on the amount of insulation in it. The report then provides step-by-step methods for calculating basement heat loss including instructions for finding numerical values for F-factors, soil conductivity, and below-grade UA. The modified F-factor method can handle different heating set points, heating degree bases, and soil conductivities. It is also possible, for example, to analyze floors of mixed composition and irregular wall sizes. The technique could be helpful for determining heat-loss coefficients for residential steady-state heat-loss calculations. An appendix gives calculations to allow for air infiltration and internal gains. And another gives calculations for finding the most efficient below-grade insulation levels.

TITLE: DOMESTIC HOT WATER HEATING-LOAD DETERMINATION AND CONSERVATION OPTION ASSESSMENT

REPORT AUTHOR: Danny Parker

DATE WRITTEN: June 1984

TOPICS: Calculations for finding the energy use of water heaters

SUGGESTED AUDIENCE: Energy use planners and analyzers, energy engineers

REPORT SUMMARY: Heating water accounts for about 20 percent of Montana's residential fuel use. This report is an evaluation of the economics of conserving this energy. Equations are provided for calculating heat load, standby losses, usefulness of conserving standby losses, and optimum insulation levels. Using this data, a researcher can calculate water heating energy conservation in either Btus or dollars.

DUO-TANG